This document was prepared in conjunction with work accomplished under Contract No. AT(07-2)-1 with the U.S. Department of Energy.

TECHNICAL DIVISION
SAVANNAH RIVER LABORATORY

[redacted]

ACC NO. 409814

~~DPST-68-481~~

UNCLASSIFIED

~~This document consists of 24 pages, No. 25 of 26 copies, Series a.~~

DISTRIBUTION:

1. B. C. Rusche, SRL
2. J. W. Croach, Wilm.
3. A. A. Johnson
4. F. E. Kruesi, SRL
5. C. H. Ice
6. G. Dessauer
7. E. C. Nelson
8. S. Mirshak
9. A. H. Peters
10. G. F. Merz
11. P. L. Roggenkamp
12. J. A. Smith
13. N. P. Baumann
14. J. R. Hilley
15. D. E. Hostetler
16. R. M. Satterfield
17. T. C. Gorrell
18. J. W. Folsom
19. W. P. Bebbington, SRP
20. L. W. Fox
21. O. A. Towler
22. L. A. Heinrich
23. E. O. Kiger
24. F. D. Benton
25. TIS File Copy
26. Vital Records Copy

TIS FILE RECORD COPY

August 8, 1968

Classification Cancelled
By Authority of
Name
Date

~~CLASSIFICATION REVIEW FOR DECLASSIFICATION BUT LEFT UNCHANGED~~
~~By~~
~~Date 2/12/73~~
~~U.S. AEC Division of Classification~~
CG 120.11

MEMORANDUM

TO: B. C. RUSCHE

FROM: R. M. SATTERFIELD - J. R. HILLEY

MARK 14-30 EXPERIMENTS IN THE PDP

INTRODUCTION

A series of experiments with a full charge of Mark 14-30 assemblies (see Figure 1) has recently been completed in the PDP. These experiments were done to provide basic enriched-depleted lattice physics information for both direct use in production reactor operation and checkout of the computer codes used to calculate physics and safety parameters.

The primary objective of this series of experiments was the measurement of the shutdown margin following insertion of safety rods and emergency addition of H_2O to the coolant channels. Preliminary SE experiments and calculations had indicated that the H_2O addition effect was large and that the actual shutdown margin might be very close to the minimum shutdown margin of 1% k_{eff} required by Technical Standards. This series of experiments was done to establish a realistic estimate of the shutdown margin in the Mark 14-30 charge.

[redacted] UNCLASSIFIED

In addition, the initial reactivity of the Stage 1 loading was determined, the worth of the safety rod system was measured as a check of calculated results, and the reactivity effect resulting from the removal of various combinations of fuel and target assemblies was measured for use in safety studies involving incidents of fuel and/or target melting.

SUMMARY

Recent full pile measurements in the PDP showed that the initial reactivity held in control rods in a Mark 14-30 lattice, as originally designed, would be too low to ensure good reactor control at minimum reactivity in the charge. The original target complement of Mark 30A's everywhere except Gang III was changed such that a third of the targets in Gangs I, II, and the buckled zone were replaced with Mark 30B's. The observed margin of control of 520 µB for the P-1.1 cycle was in good agreement with the margin of control of 510 µB derived from PDP measurements and calculated corrections for differences in loadings.

The measurements showed that large increases in reactivity could accompany the removal of one or more target assemblies in this lattice (up to about 0.43% k_{eff}) as postulated in some of the incidents used for safety analyses. Since the removal of a driver assembly had a negative effect on reactivity (about -0.14% k_{eff}), the coolant flow rates in the initial production charge were adjusted to ensure that a driver assembly would melt prior to a target assembly in the unlikely event of a reactivity transient with no scram protection.

Light water addition measurements verified that, with production safety rods in the core and the supplementary safety system ink injected but not well distributed, a minimum shutdown margin greater than 1% k_{eff} could be maintained following the emergency addition of H_2O. There was also general agreement between the PDP and the SE light water addition measurements.

A direct measurement of the worth of the safety rod system in the all-D_2O case made by the pulsing technique showed that initial calculated worths were conservative. The pulsed measurement indicated a safety rod system worth of about 7% k_{eff} compared to an early estimate of 5% k_{eff} based on PDQ calculations made by TPD.

DETAILS

Reactivity Measurements

The Mark 14-30 physics design calculations had indicated that ~ 150 μB would be held in rods at minimum reactivity during the operation of the Stage 1 production lattice. Since large errors in this result could affect the operability of the charge, a brief series of PDP measurements were made to check this result.

Measurements were made to determine the septifoil loading required to make the PDP critical at full water height. All measurements were made with rods fully inserted and an effort was made to keep the septifoil loading as uniform as possible.

The two measurements of interest in the reactivity determination are summarized in Table I. The reactivity held in rods in each case was estimated using calculated statistical weights and rod worths measured in the SE. This number, corrected for differences in full and reduced water heights where necessary, represents the reactivity held in rods in the cold, clean critical condition in the 100 Area lattice. The results of the two individual measurements agree well, the average being about 360 μB. This compares with a calculated result of 500 μB.[1]

About five days of 100 Area reactor operation are required before ^{239}Pu begins to build in, and during this time a loss in reactivity occurs due to the build-in of Xe and Sm, the power coefficient, and burnup of ^{235}U. This loss was estimated by TPD to be about 360 μB. Thus, at the point of minimum reactivity, essentially no control rods would be in the reactor whereas calculations had indicated the reactivity held in rods would be as high as 150 μB. Adequate control for flux shaping and operation of the reactor cannot be maintained without some control rods in the reactor. For this reason the target complement in the first production charge (P-1.1) was modified. A Mark 30A was exchanged for a Mark 30B in each hex of Gangs I and II and some 30A's were exchanged for 30B's in the buckled zone. The PDP loading was not changed and remained the same as had been initially planned for the production reactor.

H_2O Addition Measurements

Early in the Mark 14-30 experimental program, a series of measurements was made in the SE to determine the change in material buckling caused by replacing various fractions of the D_2O coolant by H_2O in drivers and targets as would be the case if emergency H_2O addition was necessary in the 100 Area. The results are summarized in Figure 2 and show a large increase in buckling as the H_2O content in the coolant increases. Some of these cases were also calculated using PDQ. Comparisons between calculations and SE measurements illustrated in Figure 2 show appreciable disagreement at 50% H_2O and very wide disparity at 100% H_2O. The fundamental reasons for this disagreement have not been resolved.

The effects of H_2O addition to the full production lattice were determined using PDQ calculations which had been normalized to the SE results. Technical Standard DPSTS 105-2.04 requires that the combined worth of the safety rod system plus the supplementary safety system be adequate to maintain a production reactor subcritical by a margin of 1% k_{eff} following emergency H_2O addition. The PDQ calculations indicated this margin was 1.3% k_{eff} with 100% H_2O in the coolant channels (SE measurements at 50% and 100% H_2O showed the largest H_2O effect with 100% H_2O in coolant channels). This result included the worth of the supplementary safety system which was calculated to be only 0.2% k_{eff}.

Because of the disagreement between calculations and experiments, and the small magnitude of the calculated margin, a series of H_2O addition measurements was made in the PDP utilizing the full production lattice. The objectives of these measurements were to measure the minimum shutdown margin and to investigate the disagreement between the results of SE measurements and PDQ calculations. Initial measurements were made with D_2O in the coolant channels to provide a base case for the H_2O addition experiments and to determine the initial cold, clean septifoil loading required for criticality and flatness. Measurements were then made with 50% D_2O-50% H_2O in the coolant channels of the drivers only, and with all H_2O in the coolant channels of the drivers only.

The results of the measurements with H_2O in the coolant channels of the drivers (Mark 14's) only are shown in Figure 3. The results indicate that the shape of the ΔB^2 vs. H_2O content curve measured by the SE agrees more closely with the critical measurement than does that calculated by the PDQ code.

The septifoil loading required for critical at full water height in the all-D_2O case corresponding to the cold, clean critical condition consisted of 24 septifoils each with 14.4S + 3.2S rods, and 37 septifoils each with two 3.2S rods. Because the safety rods and supplementary safety system must override the temperature coefficient (about 70 μB), as well as the effect of H_2O in the coolant channels, the septifoil loading was changed to nine clusters each with a single 3.2S rod and 52 clusters each with two 3.2S rods to mock up the hot, clean conditions. The D_2O coolant was then replaced with H_2O in both targets and drivers, and safety rods were inserted in all 100 Area safety rod positions. Pulsing and static measurements to determine the shutdown margin were made with this loading.

The degree of subcriticality was measured directly by inserting pulses of fast neutrons obtained from the neutron generator and observing the decay characteristics of the pulses. The average result of these measurements was 1.4 ±0.2% k_{eff} subcritical with all sixty-six 100 Area safety rods inserted. The pulsing measurements were made at three different water heights in the PDP, and each was extrapolated to full water height using a measured value of M^2 (110 cm^2) and the change in axial buckling. The results are shown in Figure 4.

Static measurements were also made to determine the shutdown margin. The subcritical reactor described above was made critical at full water height by removing the nine safety rods shown in Figure 5. The worth of the nine rods which were removed is equivalent to the shutdown margin and the next series of experiments were made to determine this worth. The worth of a safety rod as a function of its position in the reactor was obtained by removing individual rods from the critical reactor at various radii, and measuring the resulting change in critical water height. The results of these measurements are given in Figure 6. This curve is not directly applicable in determining the worth of the nine uninserted safety rods because the curve changes somewhat as the nine safety rods are added. By combining rod worths obtained from the curve and using PDQ to calculate the change in rod worths as the nine rods were inserted, the margin was determined to be 1.1% k_{eff} compared with the 1.4% k_{eff} result of the pulsed measurements. The average of the two values was taken to be 1.2% k_{eff}.

The worth of a mockup of the supplementary safety system was measured by the pulsed technique in the PDP at a water height of 240 cm and with all 66 safety rods in. It was assumed that the supplementary safety system injected "ink" only into the moderator immediately adjacent to the sparjets and that moderator associated with the 12 closest fuel and target positions. This ink dispersion was approximated by 18 B_4C rods (stainless steel sheath, 0.777" ID and 0.875" OD, with 75% theoretical density of B_4C) surrounding each sparjet position, and located as shown in Figure 7. The worth of this mockup was 0.8% k_{eff} and, under the assumption above, is considered to be a conservative estimate of the worth of the supplementary safety system. One other factor must be considered in determining a conservative value for the shutdown margin. Recent calculations and SE experiments indicated that a mixture of 75% H_2O and 25% D_2O in the coolant channels of all assemblies produces a slightly larger buckling increase than 100% H_2O. This correction reduces the margin by 0.1% k_{eff} for the original Stage 1 loading.

Some additional corrections must be made to determine a result which is applicable to the initial production charge (P-1.1). The change in the target loading (one Mark 30A to Mark 30B in each hex of Gangs I and II and some Mark 30A's to 30B's in the buckled zone to increase the reactivity) was assumed to have no effect on the shutdown margin. Although supporting measurements with the SE and calculations indicated that these replacements would increase the shutdown margin by about 0.2% k_{eff}, substitution measurements in the PDP indicated that the effect would be very small, and possibly in the opposite direction. For this reason, no credit is taken for this change.

In an effort to more accurately monitor the axial flux in the driver assemblies, some lattice rearrangement was done by moving driver assemblies closer to several axial power monitors. This rearrangement reduced the effectiveness of twelve 100 Area safety rods. SE measurements indicate this reduction in safety rod worth reduces the shutdown margin by -0.4% k_{eff}. The peaking resulting from this rearrangement necessitated return to the original lattice pattern. (See note on bottom of Table 2.) Finally, the ^{235}U content in the initial 100 Area charge is slightly greater than the charge loaded into the PDP (1667 g/assembly in P-1.1 vs. 1650 g/assembly in PDP). This results in a further reduction in the margin of about -0.1% k_{eff}.

A summary of the results and the appropriate corrections are presented in Table 2.

Measurement of Safety Rod System Worth (All D_2O)

A direct measurement of the worth of the 100 Area safety rod system in the Mark 14-30 lattice was made utilizing the pulsing technique. This was the first time such a measurement has been made for a 100 Area lattice.

With D_2O in the coolant channels of all assemblies and the septifoils loaded to mock up the cold, clean critical condition, all sixty-six 100 Area safety rods were inserted and the subcritical reactor was pulsed at full water height to determine the worth of the safety rod system. This worth was 7.0 ±0.7% k_{eff}.

The worth of the safety rod system may be calculated utilizing a PDQ mockup of the full production lattice. The safety rods are represented by rectangular regions overlaying each safety rod location. The thermal absorption cross sections in these regions are increased to account for the additional poison attributable to the safety rods. All other diffusion parameters for the safety rod region remain the same as they were without safety rods. The PDQ mesh line orientation and the relative location of a safety rod region in the E-D lattice are shown in Figure 7A.

SE safety rod measurements provide the means for determining the value of $\Sigma_a{}^{th}$ to be assigned to the safety rod regions. A PDQ mockup of the SE is constructed utilizing the same mesh line grid used in the production lattice mockup. The k_{eff} of the SE mockup with no safety rods is calculated using a value for the vertical buckling measured in the SE for that case. The input buckling is then changed to that value measured in the SE with safety rods in place. The thermal Σ_a of the safety rod region is then increased until the calculated k_{eff} matches the value determined previously. This $\Sigma_a{}^{th}$ may then be used in the production mockup to calculate the worth of the full safety rod system. This technique indicated a worth of 7.0% k_{eff}, which is the same as the measured result.

Early in the Mark 14-30 calculational program the worth of the safety rod system was calculated to be 5.1% k_{eff}.[3] However, the SE safety rod measurement referred to above had not yet been made and PDQ safety rod parameters for these calculations were obtained by normalization to a set of SE safety rod measurements in a lattice using 3400 g ^{235}U drivers and Mk 30A targets. In addition, a different calculational method was used. To insure that the difference between the calculated safety rod worths was not due to the method of calculation, this earlier series of calculations was repeated using the SE Mark 14-30 measurements as a basis for normalization.

In this latter method a finer mesh line grid was used in the PDQ-SE mockup, allowing a more detailed calculation of the radially dependent flux to be made. Also the area of the rectangular safety rod regions was much smaller. An example of the mesh line orientation and the safety rod region is shown in Figure 7B. The process of determining a value for Σ_a^{th} of the safety rod region is the same as has been previously described.

The fine mesh line grid cannot be used in the full production mockup due to computer limitations, thus it is necessary to smear the safety rod poison over a larger region for use in the production mockup. The region chosen consisted of the three driver cells surrounding each safety rod. The smearing out of the poison is accomplished with the flux weighting edit in PDQ.

With these safety rod parameters, the worth of the production safety rod system was again calculated. The result of these calculations was 6.9% k_{eff}, indicating that either calculational method gives acceptable results.

Reactivity Effects of Fuel and Target Removal

Experiments were made to determine the reactivity effects resulting from the removal of various numbers of fuel and target assemblies. The objectives of these measurements were to gain some insight into the effects of fuel and target melting in a mixed lattice of this type and to provide basic data which could be used in conjunction with calculations to investigate realistic accident conditions.

The assemblies that were used in these experiments are indicated in Figure 8. To maintain a desirable range of critical water heights during measurements of both positive and negative reactivity effects, two reactor loadings were used in the measurements; sparjets in place and sparjets replaced with fuel and target assemblies. The radial distribution of flux is different for the two cases and normalization is necessary for comparisons.

The reactivity changes resulting from the removal of driver and target assemblies depend upon both the assembly location and the radial distribution of flux. Consequently, the PDP measurements do not necessarily represent the maximum effects; but they can be used for comparison with calculation.

The measurements, summarized in Table 3, show that (with sparjets in place) the removal of a single Mark 30A target assembly from Gang II increases the reactivity of the PDP by 0.43% k_{eff} and the removal of two adjacent Mark 30A assemblies from the same area increases the reactivity by 1.47%. Part of the large increases in reactivity in these two cases was due to enhancement by the radial flux tilt that resulted from the removal of the target assembly.

To provide a direct comparison with the PROD HERESY code, single Mark 30A assemblies were removed from three symmetric positions with respect to the center of the PDP (thus preventing a flux tilt), and the increase in reactivity was 0.81% k_{eff}; equivalent to 0.27% k_{eff} per assembly. The calculated value was 0.33% k_{eff} per Mark 30A.

For the case in which one Mark 30A target was removed, gold pin irradiations were made to determine the flux peaking in assemblies adjacent to the empty position. The gold pins were taped to the adjacent driver and target housing tubes, and also to the housing tubes of the adjacent driver and target assemblies in symmetric locations in the other two 120-degree sectors of the charge (Figure 9). Six pins were taped to each tube, all at the same height and so oriented that each pin faced one of the six surrounding lattice positions.

The gold pin irradiations show that the thermal flux at the driver and target assemblies adjacent to the empty lattice position is 2.6 to 2.8 times higher than the flux at the symmetric locations (without an empty position) in the other sectors. In addition, azimuthal variations in the flux of up to 25% was measured at the housing tubes of assemblies adjacent to the empty lattice position, as shown in Figure 10. The corresponding azimuthal variations around the symmetric irradiation assemblies in the two undisturbed sectors did not exceed 8%.

In a lattice where the sparjets were replaced with drivers and targets, the removal of a single Mark 14 driver assembly from Gang II decreased the reactivity of the lattice by 0.11% k_{eff} and the removal of a single target assembly increased the reactivity by 0.32% k_{eff}, compared to the 0.43% with the flatter radial distribution with sparjets in place.

To provide for further comparisons with calculations, the effect of removal of adjacent driver-target pairs was also measured in the lattice with no sparjets. Removal of an adjacent driver-target pair from Gang II gave only a slight reactivity increase, 0.015% k_{eff}. Removal of two adjacent pairs from the same region increased the reactivity by 0.029% k_{eff}. However, when four adjacent pairs of drivers and targets were removed, leakage probably became dominant, and the reactivity was decreased by 0.005% k_{eff}.

Results of PROD HERESY calculations have been compared to several of the experiments discussed above. Because this code assumes 120-degree rotational symmetry and any perturbation in one sector of the lattice is implied for the other two, it does not calculate radial flux tilts that result from asymmetric perturbations. In cases with small tilt, such as the removal of driver-target pairs, PROD HERESY can be used to calculate both the magnitude and sign of the effect on reactivity. In cases where the flux tilt is large, as in the removal of a single target assembly, the predicted sign of the effect should be correct but the calculated magnitude will be in error.

The calculated results are summarized in Table 3. All calculations are for the lattice with sparjets in place; in only one case (targets removed from positions 1, 1A, and 1B) can the calculation be compared directly with an experiment. The calculated reactivity change for this case is an increase of 0.98% k_{eff}, which is somewhat larger than the measured value of 0.81%. In most cases, the signs of the reactivity changes are predicted well, as expected. Although the calculations do not describe the experiments exactly, the reasonably good agreement between magnitudes of the changes indicate that the PROD HERESY code can be used to calculate the effect of vacant positions for radial distributions of flux and locations of assemblies other than those used in the experiments. These calculations must be normalized to experiment if the reactivity change is large enough to cause a radial tilt in the reactor. Alternatively, a code such as PDQ could be used to calculate these radial tilts.

Measurements and analysis are continuing on the effects of loss of target assemblies.

RMS-JRH:shb

REFERENCES:

1. DPST-68-228, "Revised E-D Lattice," Memorandum, T. C. Gorrell to P. L. Roggenkamp, January 19, 1968.

2. DPSP-68-1-4, Works Technical Department Report for April 1968, p. 151.

3. DP-67-1-4, Savannah River Laboratory Monthly Report, April 1967, p. 29.

TABLE 1

PDP E-D REACTIVITY MEASUREMENTS

A. With 2 - 3.5 w/o rods in all septifoils:

Critical water height	=	355 cm
Critical vertical buckling	=	87 µB
Reactivity held in rods	=	321 µB
Reactivity needed to compensate for water height correction to 450	=	34 µB
Reactivity held in rods at full water height	=	355 µB

B. With 1 - 3.5 w/o rod and 1 - 14.48 rod in 24 septifoils, and 2 - 3.5 w/o rods in 37 septifoils:

Critical water height	=	450 cm
Critical vertical buckling	=	53 µB
Reactivity held in rods	=	365 µB
Reactivity needed to compensate for water height correction	=	0 µB
Reactivity held in rods at full water height	=	365 µB

TABLE 2

SHUTDOWN MARGIN FOR MARK 14-MARK 30 CHARGE WITH H_2O, % k_{eff}

Beginning of Stage 1 Subcycle

Measured in PDP with 100% H_2O, 66 plant safety rods and mockup of hot clean condition			
Static measurement		1.1	
Pulsing measurement		1.4	
	Avg.	1.2	
Increment with mockup of poisoning by supplementary safety system		0.8	
Increment due to 75% H_2O rather than 100% for maximum reactivity		-0.1	
Adjustments to plant conditions			
One Mark 30B per hex to increase initial reactivity		0.0	
Rearrangement for axial monitoring*		-0.4	
1667 g of fuel per assembly		-0.1	
		-0.5	
Total shutdown margin, beginning of cycle			1.4 ±0.3%

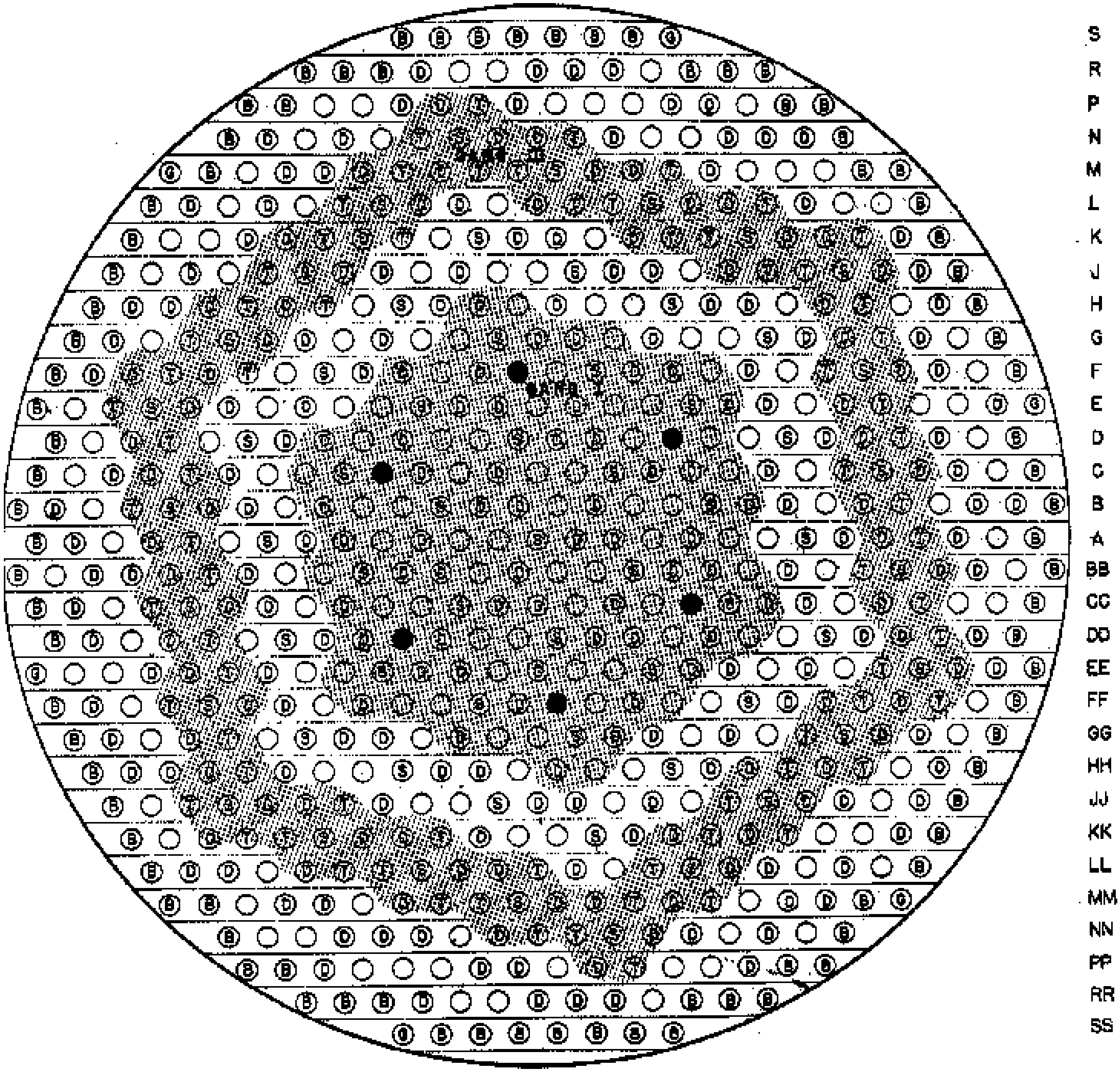
*The production reactor was shut down at low exposure when it was observed that excess peaking (up to 50%) was observed near the rearranged positions. The lattice was changed back to the original arrangement and three safety rods were replaced with APM's. The total shutdown margin in this condition was 1.5% k_{eff}.

TABLE 3

REACTIVITY CHANGES RESULTING FROM DRIVER AND TARGET REMOVAL

Assemblies Out	Positions*	Measured Reactivity Change, % k_{eff}: Sparjets In	Measured Reactivity Change, % k_{eff}: Fuel and Targets In Place of Sparjets	Calculated Reactivity Change, % k_{eff}: Sparjets In
One Mark 30A	1	+.0043	+.0032	+.0033
Two Mark 30A's	1,8	+.0143	-	-
Three Mark 30A's	1,1A,1B	+.0081	-	+.0098
One Mark 14	2	-.0015**	-.0011	-.0014
One Mark 14) One Mark 30A)	1,2	-	+.00015	+.0027
Two Mark 14) Two Mark 30A)	1,2,3,4	-	+.00029	+.0048
Four Mark 14) Four Mark 30A)	1,2,3,4 5,6,7,8	-	-.00005	+.0037

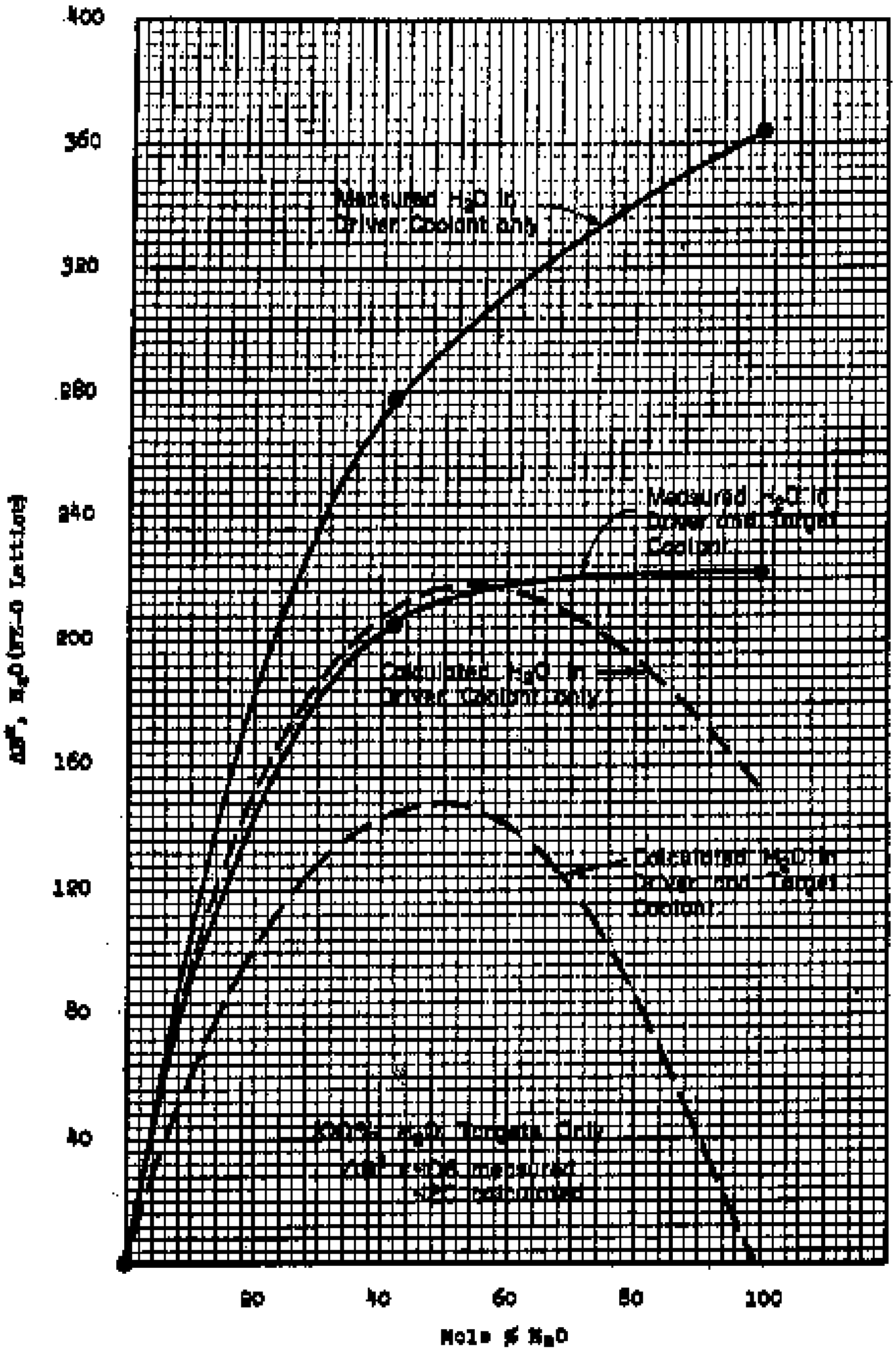
*See Figure 8.
**Not measured. Extrapolated from the relative worths of removal of single Mark 30A assemblies.



PDP - MARK 14-30 - ED LATTICE

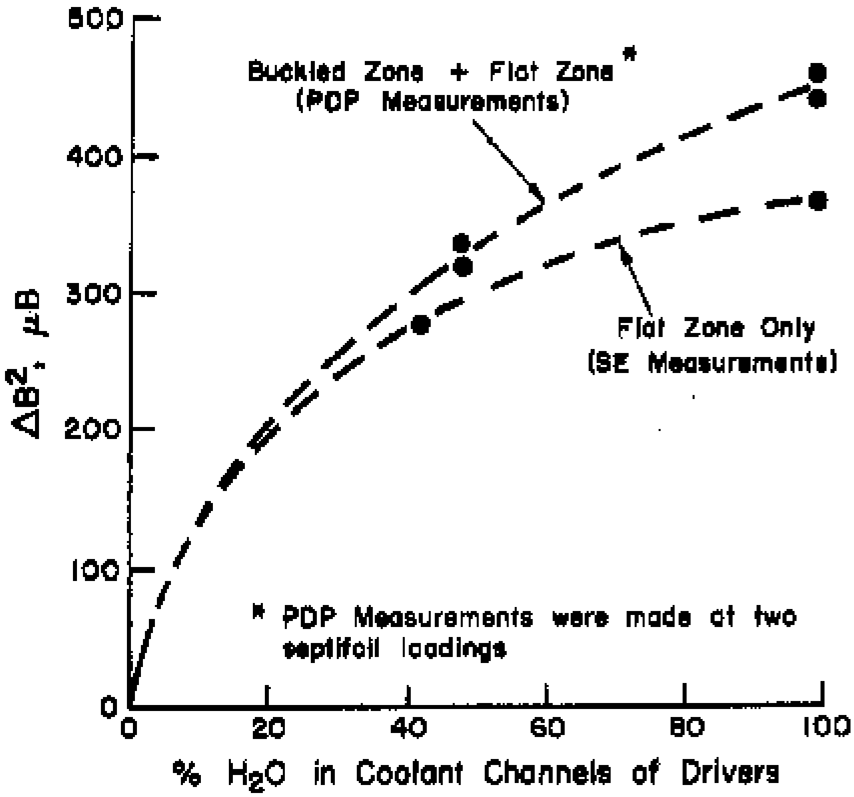
●	SPARJET	SEPTIFOIL	Ⓢ
Ⓓ	MARK 14 DRIVER	GAS PORT	Ⓖ
○	MARK 30A DEPLETED URANIUM	DEPLETED URANIUM BLANKET	Ⓑ
Ⓣ	MARK 30B (Gang III Only)		

FIGURE 2



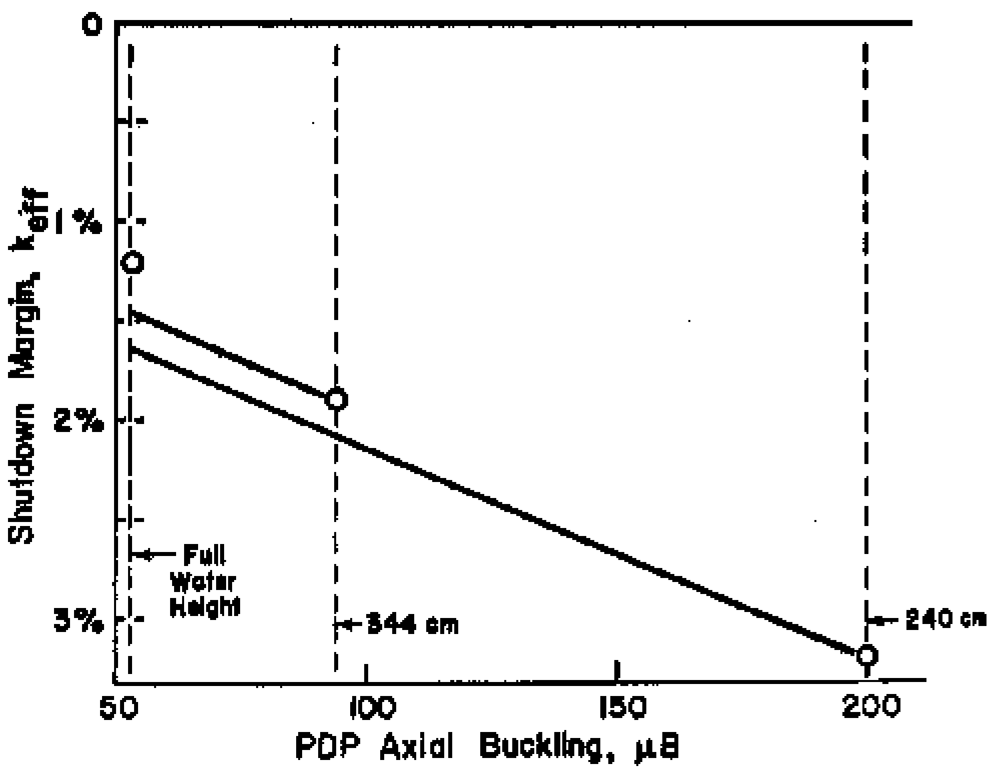
EFFECTS OF ADDITION OF H_2O TO MK 14-30 LATTICE

FIGURE 3

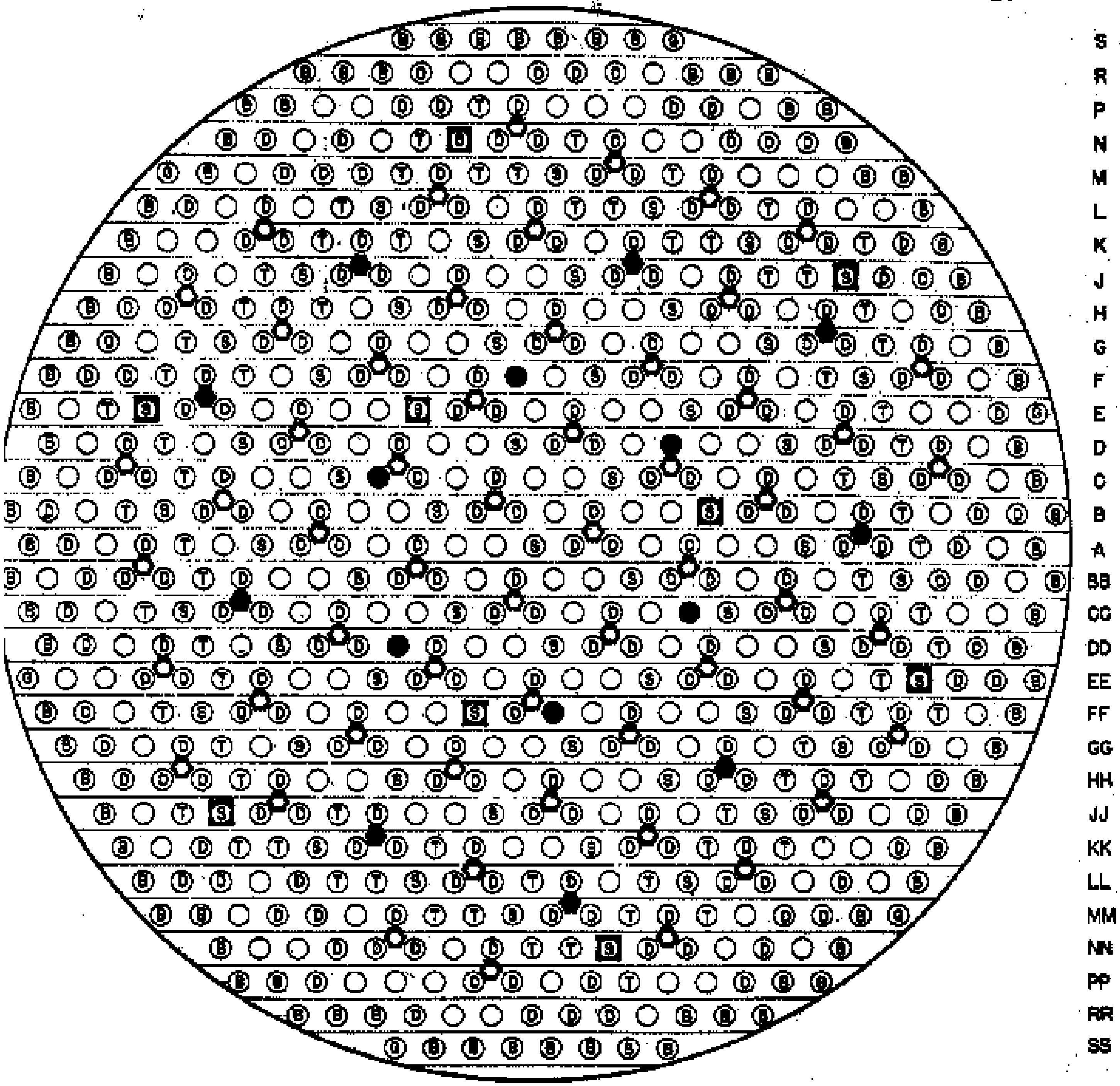


MARK 14 & 30 LATTICE - EFFECTS OF H_2O ADDITION TO DRIVER ONLY

FIGURE 4



SHUTDOWN MARGIN BY PULSING



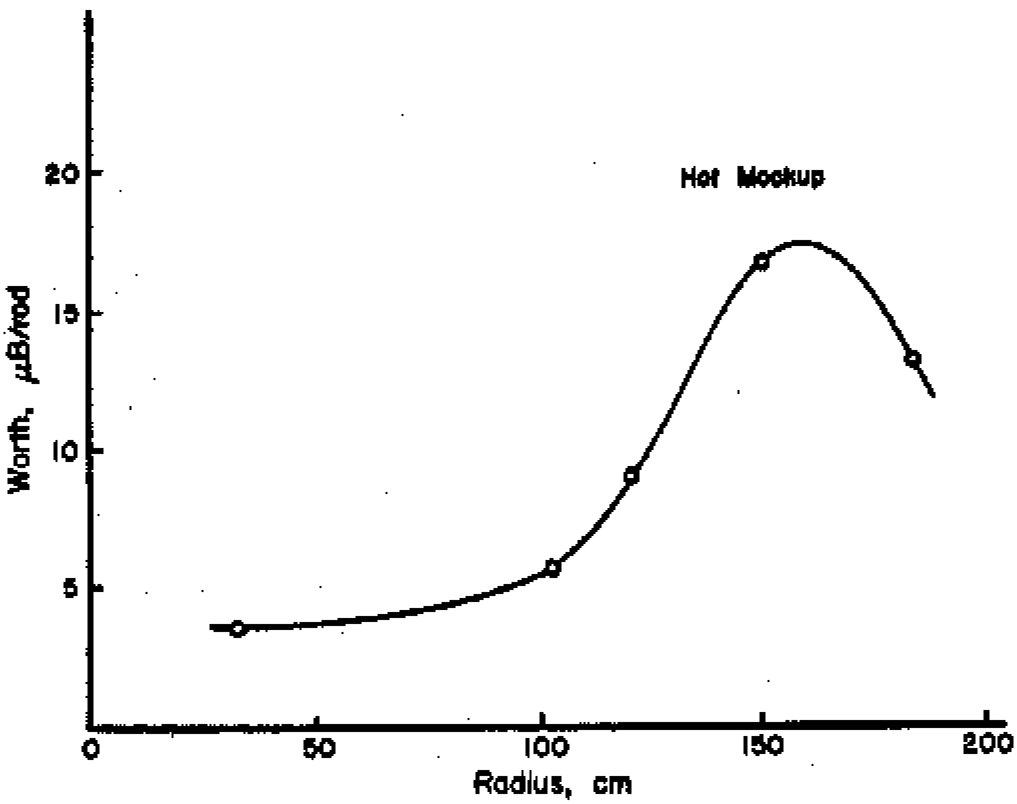
PDP MARK 14-30-E. D. LATTICE

SAFETY ROD LOCATIONS

●	SPARJET	SEPTIFOILS	1-3-20 ROD / 2-3-20 RODS
Ⓓ	MARK 14 DRIVER	GAS PORT	
○	MARK 30A DEPLETED URANIUM	DEPLETED URANIUM BLANKET	
Ⓣ	MARK 30B (Comp III Only)		
	100 AREA SAFETY RODS		
	SAFETY RODS OUT AT CRITICAL		

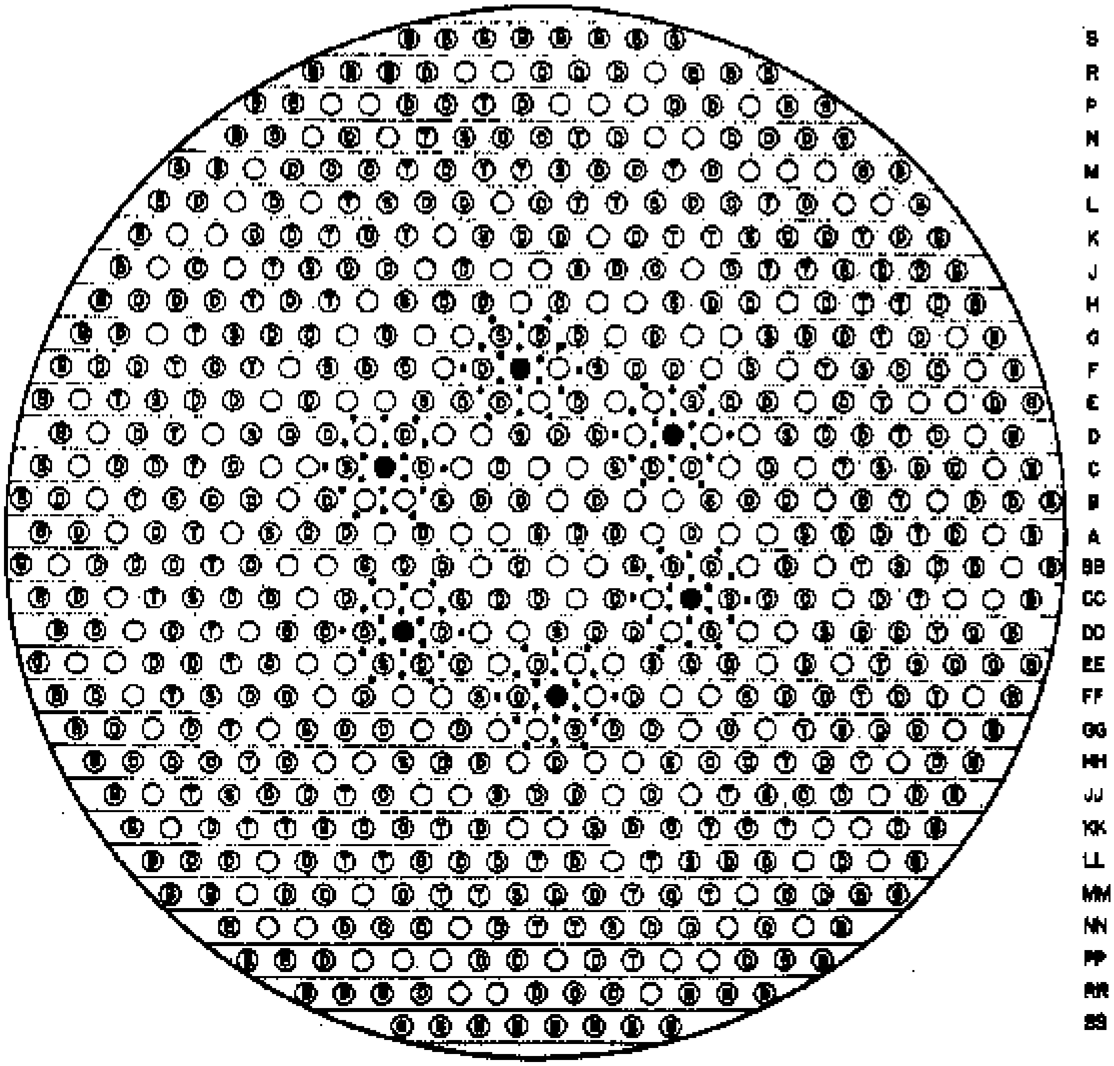
UNCLASSIFIED

FIGURE 6



SAFETY ROD WORTH - PDP MEASUREMENTS

FIGURE 7



● SPARJET	SEPTIFOIL Ⓢ
Ⓓ MARK 14 DRIVER	GAS PORT Ⓖ
○ MARK 30A DEPLETED URANIUM	DEPLETED URANIUM BLANKET Ⓑ
Ⓣ MARK 30B (Gang III Only)	
• 0.777" OD B_4C ROD	

SUPPLEMENTARY SAFETY SYSTEM MOCKUP

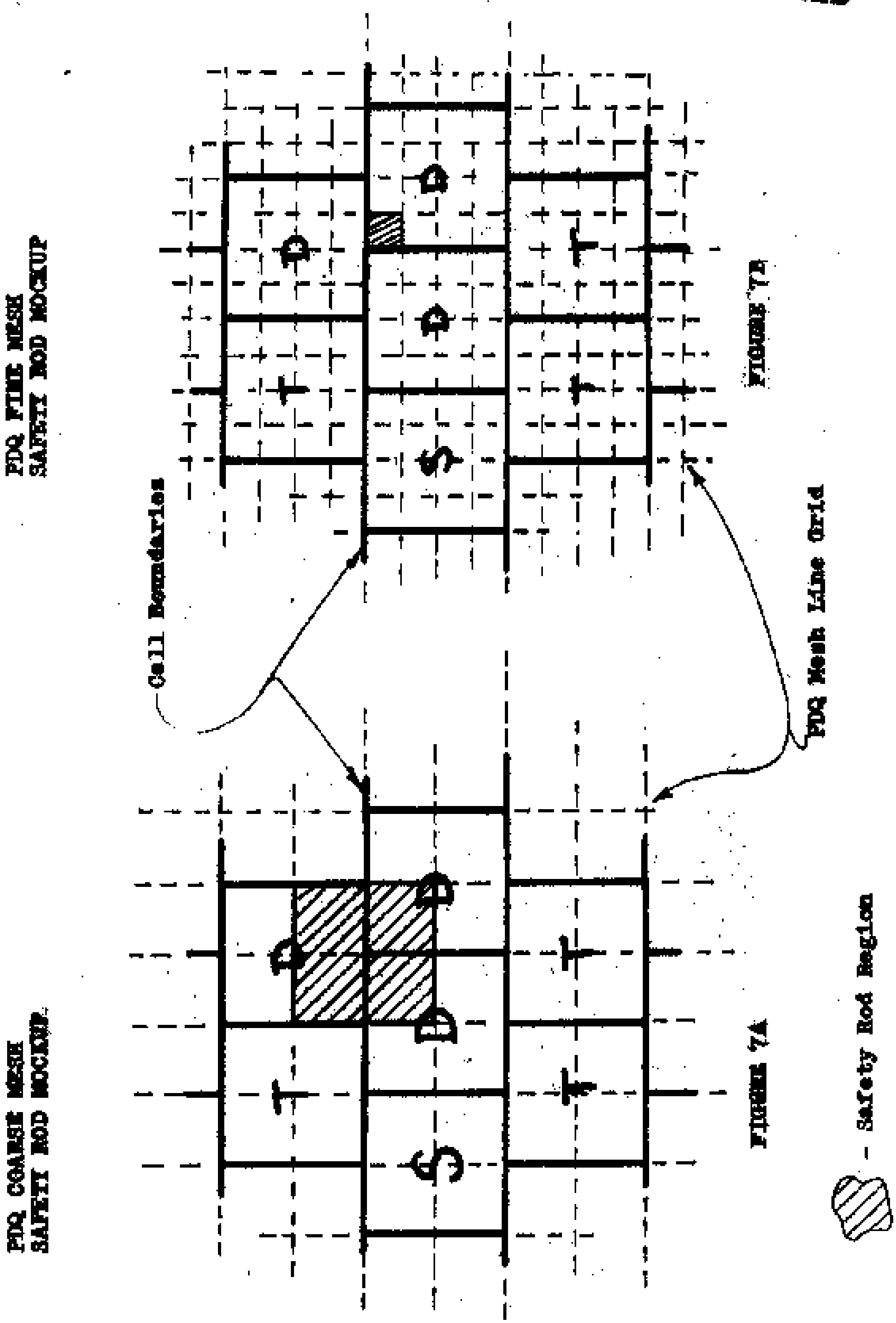
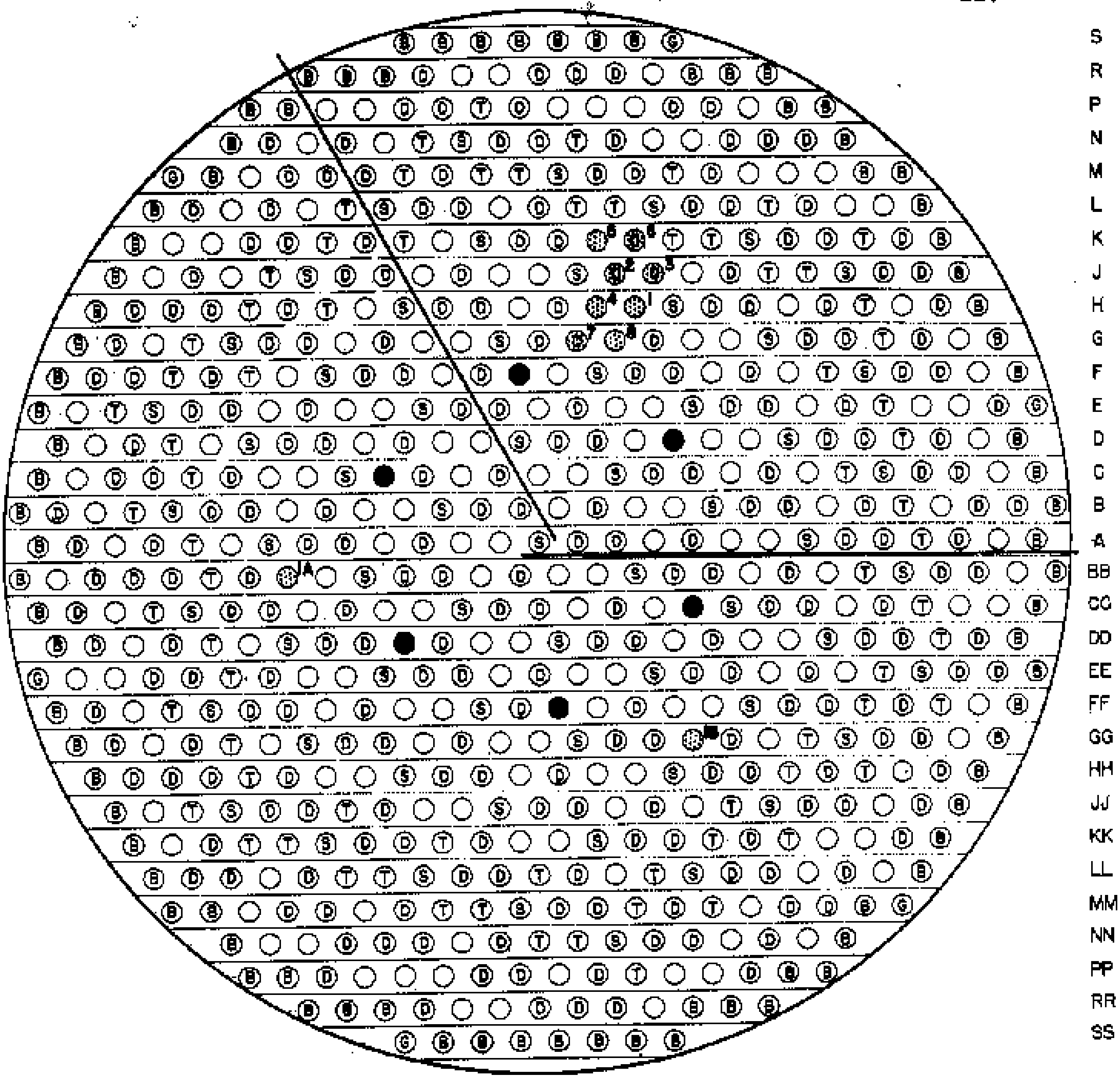

PDQ FINE MESH
SAFETY ROD MOCKUP
FIGURE 7B
Cell Boundaries
PDQ Mesh Line Grid
PDQ COARSE MESH
SAFETY ROD MOCKUP
FIGURE 7A
- Safety Rod Region
D
T
S

FIGURE 8 **UNCLASSIFIED**



PDP MARK 14-30-E.D. LATTICE

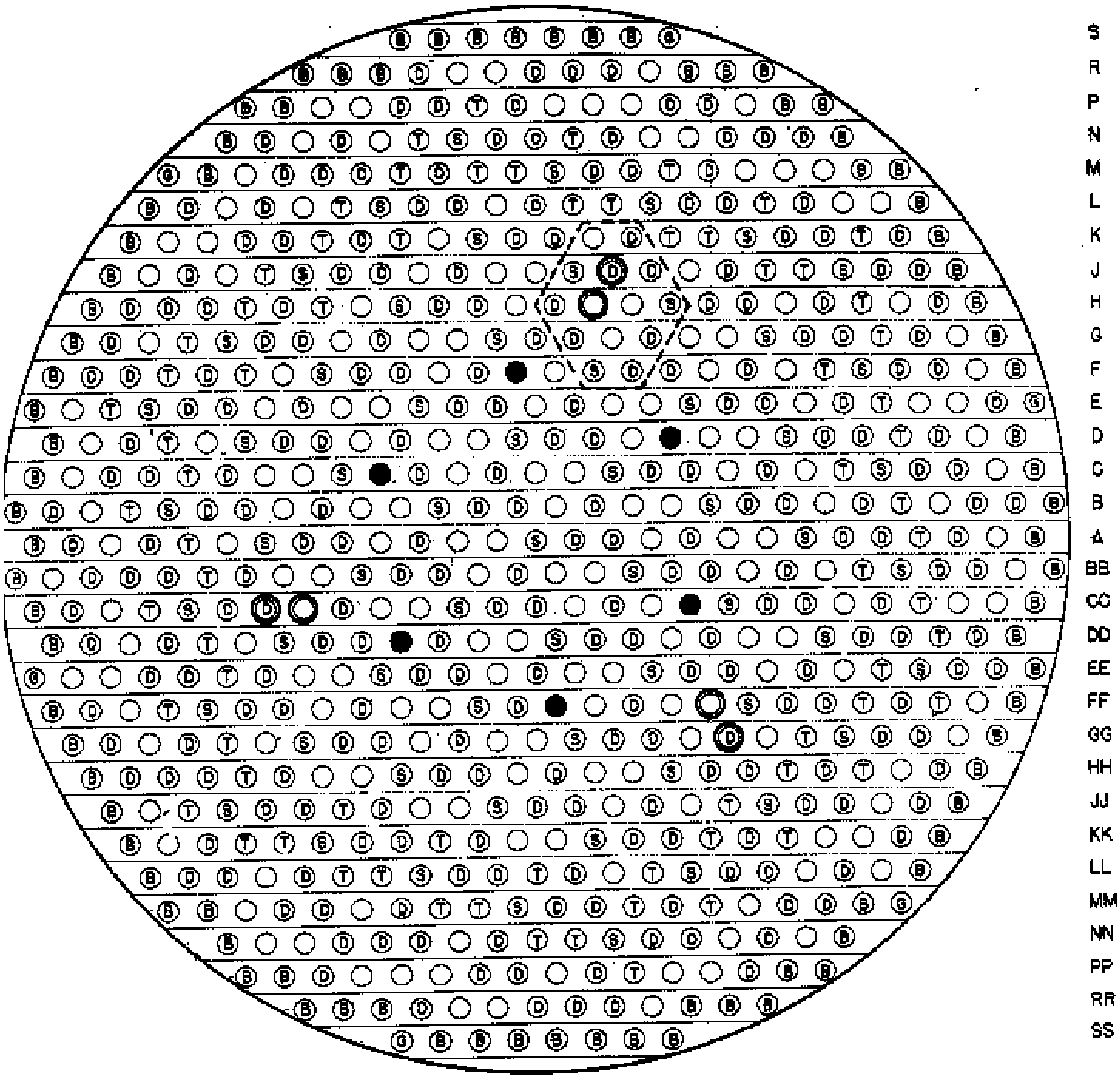
●	SPARJET	SEPTIFOIL	Ⓢ
Ⓓ	MARK 14 DRIVER	GAS PORT	Ⓖ
○	MARK 30A DEPLETED URANIUM	DEPLETED URANIUM BLANKET	Ⓑ
Ⓣ	MARK 30B (Gang III Only)		

Drivers and targets in numbered positions were removed. See Table 3.

UNCLASSIFIED

[redacted]

FIGURE 9 UNCLASSIFIED [redacted]

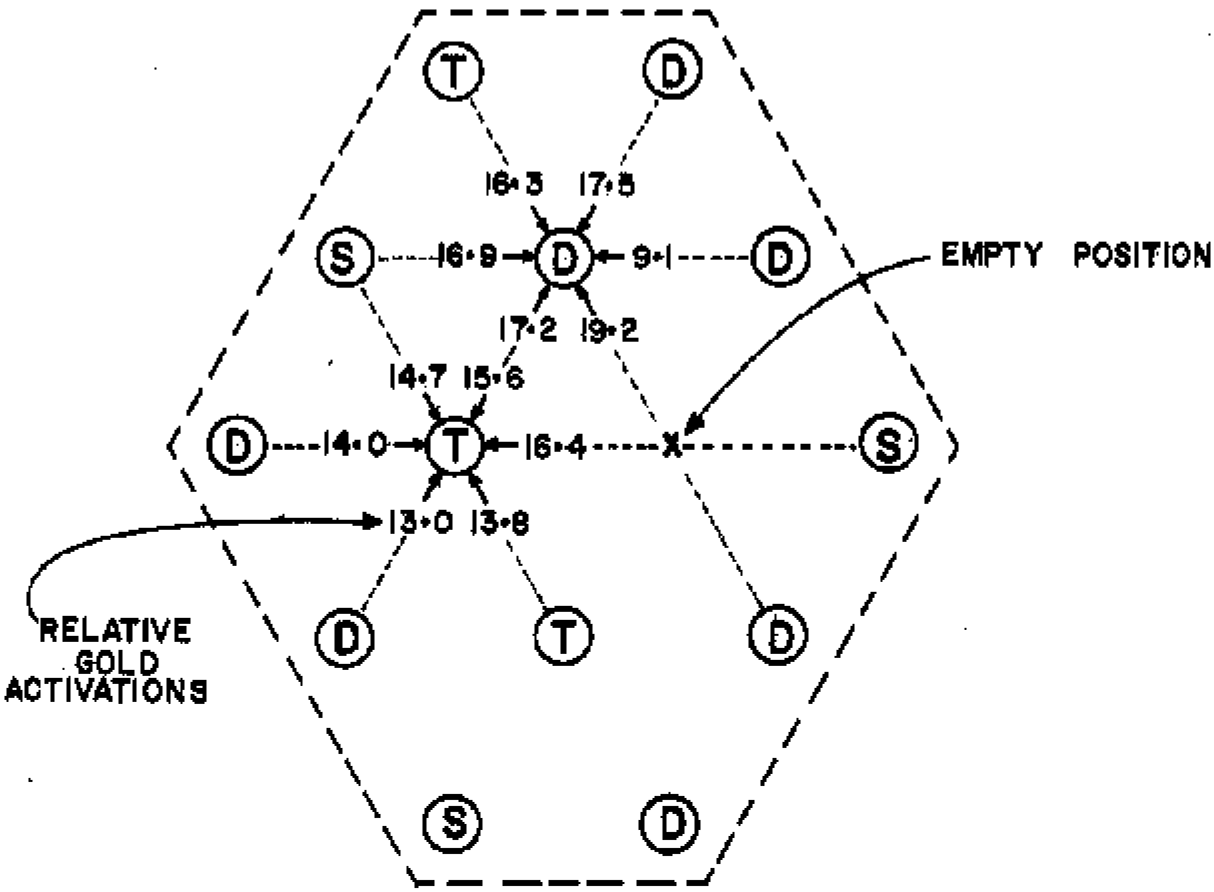


MARK 14 - PDP - ED PROGRAM

● SPARJET	SEPTIFOIL (S)
(D) MARK 14 DRIVER	GAS PORT (G)
○ MARK 30A DEPLETED URANIUM	DEPLETED URANIUM BLANKET (B)
(T) MARK 30B (Gang III Only)	IRRADIATION ASSEMBLIES

[redacted] UNCLASSIFIED

FIGURE 10



(D) MK-14 DRIVER

(T) MK 30A TARGET

(S) SEPTIFOIL

LOCAL FLUX PEAKING DUE TO REMOVAL OF MK 30A TARGET